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On the whole, however, it seems clear that this instrument is of great value in measuring the actual influence of air conditions upon the body and is greatly superior to the ordinary thermometer for this purpose. Compare for instance observations 8 and 9, both made outdoors on a cloudy day, with an air temperature of 75°. In 8 the Kata thermometers and the observers were protected from the wind, while in 9 they were at the end of the porch in a breeze. The dry bulb times at these two points were 196 seconds and 105 seconds, respectively, and the comfort votes 3.7 and 2.7. In the first case it was uncomfortably warm, in the second too cool, with nothing in the reading of the ordinary thermometer to indicate any change. Again contrast observations 13 and 19, the first taken out of doors in a strong breeze, the second indoors before a fire. The ordinary thermometer registered 72° in each case, but in one instance the time for the fall of the Kata dry bulb was 115 seconds and the comfort vote 2.2; in the other case the dry bulb time was 277 seconds and the comfort vote 3.6. Out door conditions with ordinary thermometer readings of 75° (Nos. 5 and 9), 77° (No. 15), and 79° (No. 10) were more comfortable and showed lower Kata thermometer times than this room with a fire at 72°.

Most significant are the readings and the comfort votes in Table II., in which on each day conditions were noted, first without, and then with, the direct draft from an electric fan. In each case the ordinary thermometer either remained unchanged (or dropped one degree in two instances) while the Kata times and the comfort votes fell off enormously. On six different days, with ordinary thermometer readings varying from 69° to 79°, the comfort vote showed uncomfortably hot conditions and Kata dry bulb times over 170 without the fan and too cool conditions, and Kata dry bulb times under 120 with the fan turned on (observations 20-23 and 29-36). Even the condition of 87° on the ordinary thermometer (observation 26) was as comfortable and showed about the same Kata thermometer readings as were obtained without the fan at an air temperature of 72° (observation 29).

The curves as plotted suggest that the optimum for comfort (represented by an average vote of 3.0) falls close to the lower of the points suggested by Dr. Hill (45-60 seconds for the wet bulb and 150-180 seconds for the dry bulb). Too much stress can not of course be laid on a small number of observations such as are here reported, but the general value of the Kata thermometer seems sufficiently obvious to warrant its general use in the study of atmospheric conditions as they affect bodily comfort.¹¹

C.-E. A. WINSLOW

YALE MEDICAL SCHOOL

THE AMERICAN PHILOSOPHICAL SOCIETY

THE general annual meeting of the American Philosophical Society was held on April 13, 14 and 15 during which nearly fifty papers were presented on a great variety of topics. The address of welcome was made by Dr. W. W. Keen, the president, who, with vice-presidents W. B. Scott and E. C. Pickering, presided at the various sessions.

On Friday evening a reception was held at the hall of the Historical Society of Pennsylvania, after which Dr. L. O. Howard, of Washington, gave a lecture "On Some Disease-bearing Insects."

Saturday afternoon was entirely devoted to a symposium on international law in its various aspects, five papers being presented.

The program and some abstracts of the papers follow:

THURSDAY, APRIL 13

Opening Session—2 o'clock

William W. Keen, M.D., LL.D., President, in the Chair

The Popes and the Crusades: DANA C. MUNRO.

The Common Folk of Shakespeare: FELIX E. SCHELLING.

A Rare Old-Slavonic Missal: J. DYNELEY PRINCE.

On the Art of Entering Another's Body: A Theme of Hindu Fiction: MAURICE BLOOMFIELD.

¹¹ Hill, Griffith, and Flack (*Phil. Trans. Roy. Soc. Lond.*, series B, Vol. 207, pp. 183-220) have recently published an important study in which the Kata readings are translated into fundamental physical units of millicalories of heat loss per square centimeter per second.

The Isles of the Blest: PAUL HAUPT.

The Interpretation of Mythology: FRANZ BOAS.

America's Relation to the Developments of International Law: LEO S. ROWE.

Sight and Signaling in the Navy: ALEXANDER DUANE. (Introduced by Dr. Geo. E. de Schweinitz.)

Observations of the Mentality of Chimpanzees and Orangutans. (Illustrated with motion pictures.) WILLIAM H. FURNESS, 3D.

THURSDAY EVENING, APRIL 13

Meeting of the officers and council at 8:30 o'clock.

FRIDAY, APRIL 14

Executive Session—9:30 o'clock

Proceedings of the officers and council submitted.

Morning Session—9:35 o'clock

William B. Scott, Sc.D., LL.D., Vice-president, in the Chair

Two New Terms, Cormophytaster and Xeniophyte, Axiomatically Fundamental in Botany: WILLIAM TRELEASE.

Origin and Vegetation of Salt Marsh Pools: JOHN W. HARSHBERGER.

The Work of the Mellon Institute in its Relations to the Industries and to the Universities: RAYMOND F. BACON.

*The F₂ Generations, and Back-, and Inter-crosses of the F₁ Hybrids between *Oenothera nutans* and *pycnocarpa**: GEORGE F. ATKINSON.

In the F₁ generation of the cross *Oenothera nutans* × *O. pycnocarpa* there appear four hybrid types, *O. nutella*, *O. pycnella*, *O. tortuosa* and *O. tortuella*. In the F₁ of the reciprocal cross three hybrid types have thus far appeared which are identical with three of the types named, viz., *nutella*, *pycnella* and *tortuella*. It is probable that if the number of individuals was very large, *tortuosa* would also appear.

Of these four F₁ hybrid types, *nutella* is a blend, and thus far has proved absolutely self-sterile, though the pollen works on *pycnella* and *tortuosa* (it has not been tried on *tortuella*, on both of the parents, and on all other species of *Oenothera* on which it has been tried. The egg cells are also fertile in reciprocal crosses with the same forms. *Pycnella*, *tortuosa* and *tortuella* are, on the other hand, "segregate" hybrids; i. e., they select certain characters from each parent and develop them

to their full expression. *Pycnella* and *tortuosa* are "counterparts," i. e., the two together use all the characters of both parents, the one making use of the characters which the other omits. *Tortuella* appears to have all the characters of *tortuosa* except the red stem which comes from the parent *nutans*, *tortuella* having the green stem of the parent *pycnocarpa*, which is also inherited by *pycnella*. The hybrids *pycnella* and *tortuosa* are fixed in the F₁ generation, they breed true in the F₂ generation (*pycnella* has been tried in the F₂ and breeds true). *Tortuella*, however, appears to split in the F₂ generation. This result is remarkable that in the F₁ generation from a cross between two feral, non-mutating species, quadruplet hybrids appear in the F₁ generation; one is a blend and self-sterile, but its pollen and egg cells are fertile; two of the segregates are fixed types and breed true, while the fourth hybrid (3d segregate) appears to split in the second generation. The back- and inter-crosses show, either striking examples of patrocliny, or splitting into two types in some cases, into three types in other cases. But no new types (with a single exception) appear, they all conform to one or other of the six types, the primary parental types, or one or more of the F₁ hybrid types. The single exception is a mutant of the dwarf *gracilis* type.

Inheritance through Spores: JOHN M. COULTER.

The current work in plant genetics suggests the question of the most favorable material. In the main, the most complex plants have been used, so that it is impossible to analyze the factors involved. Even the origin of the embryo is not always assured, on account of the frequent occurrence of apogamy. Furthermore, only inheritance through sexual reduction is secured. If sexual forms are desirable, it seems obvious that the most primitive ones should be included in experimental material, since in such forms the sex act is not involved with other structures, the origin of the sexual cells is observable, and the whole situation lends itself to more complete control and analysis. The sexual cells, however, are genetically related to spores, so that the origin of spores and their behavior in reproduction is preliminary to the origin of gametes and sexual reproduction. Reproduction spores, therefore, is a field rich in experimental possibilities. Analysis of the conditions of spore formation furnishes a clue to the additional conditions necessary for gamete formation; experimental modification of the "germ plasm" is more simple and definite than in com-

plex material; and breeding from spores with essentially pure lines is especially favorable for securing more definite data in reference to the possibilities of variation and inheritance.

The Dynamics of Antagonism: W. J. V. OSTERHOUT.

If two toxic substances antagonize each other we call this action antagonism. An accurate measure of antagonism is afforded by determining the electrical resistance of living tissues. Toxic substances cause a fall of resistance, but if in a mixture of two such substances resistance falls less rapidly, it is evident that this is due to antagonism. In the case of the common kelp *Laminaria* NaCl causes a fall of resistance while CaCl_2 causes a rise followed by a fall of resistance. In mixtures of NaCl and CaCl_2 the resistance rises and then falls; by using the right proportions the fall may be made very gradual. We may explain these facts by assuming that the resistance is due to a substance, the production of which is accelerated by CaCl_2 while its decomposition is checked by a compound formed by the union of both NaCl and CaCl_2 with a substance in the protoplasm. This throws new light on the manner in which salts act in preserving life. It has been found that the electrical resistance is a very delicate and accurate indicator of the vitality of protoplasm, since any kind of injury is at once indicated by a fall of resistance. This permits us to give a quantitative meaning to such terms as vitality, injury, recovery and death. The mechanism by which changes in resistance are produced by salts is therefore of great importance. The facts here presented give us a new insight into this mechanism.

Jointing as a Fundamental Factor in the Degradation of the Lithosphere: FREDERICK EHRENFELD.
(Introduced by Professor Amos P. Brown.)

This paper is a study of those physical activities which are always at work to bring the surface of the earth down to a level or nearly flat surface. It includes also some discussion concerning the probable destruction of former great land masses or continents such as those believed by geologists to have existed formerly across the present oceans connecting Europe, Africa and America. In most text-books of the science the question of land surface leveling or degradation is considered more from the standpoint of the atmospheric or other surface cause than from the point of the construction of the solid portions of the earth itself. This the author of this paper considers a somewhat mis-

taken view to take of the case, as the stony mass or portion of the earth has been shown by many geologists to be subject to a constant fracturing or jointing which shows itself in various ways such as influence on river drainage, repeated groups of islands, bays along sea coasts and in certain types of volcanic and earthquake appearances. The paper discussed these and also the subject of marine planation to produce a lowering of the land below sea level. Illustrations of such marine action were shown from the Maine coast and also from the forms and positions of some of the Atlantic ocean islands. This subject of the action of the sea to produce a general leveling though a much discussed one some decades ago has been neglected by many modern students, but is now becoming prominent under newer ideas of the science, and this paper is in part a study of jointing in the mass of the lands to assist in such action and hasten continental land leveling and destruction by creating in the rock mass through joints great lines of weakness which under the attack of both the atmosphere and the sea compel the falling apart of the land. The question of former great land masses was discussed, as was also the bearing of these joints in the subject of the formation of coral reefs. In conclusion the author proposed a "law of joints" in which the controlling influence of joint lines was more definitely stated.

Sinking Islands versus a Rising Ocean in the Coral-Reef Problem: WILLIAM MORRIS DAVIS.

Since Darwin's voyage in the *Beagle*, eighty years ago, nearly all geologists who adopted his theory of coral reef accepted also his postulate that the reef-bearing islands have subsided with the subsiding ocean bottom. In later years, and largely under the leadership of the Austrian geologist, Suess, and the German geographer, Penck, the possible variation of ocean level around fixed islands has been emphasized. When it is seen that a rise of the ocean surface around still-standing islands would produce all the conditions that arise from Darwin's postulate of subsiding islands in an ocean of constant level, search should be made for some means of evaluating these two alternatives. The result of such a search shows that the theory of a changing ocean involves many extravagant complications which have not been sufficiently considered by those who accepted it; while the theory of subsiding islands is relatively simple and economical. Darwin's original theory is to be preferred on those grounds.

The Petrology of Some South Sea Islands and its Significance: JOSEPH P. IDDINGS.

The islands of Tahiti, Moorea, Huaheine, Raiatea, Tahaa, Bora Bora of the Society group, and Hiva-oa and Nukahiva of the Marquesas were visited in order to ascertain whether the volcanic rocks composing them are of such a character that they support the theory of isostasy, which demands that the deep portions of the earth's crust, or the lithosphere, under the Pacific Ocean should consist of heavier material than that underlying the continent of North America. It was found that the volcanic rocks of these islands are noticeably heavier on the average than the igneous rocks occurring in various parts of the American continent. Each of the islands visited was found to be an extinct basaltic volcano, considerably eroded, and partly submerged beneath the sea. The structure and rocks of the islands are briefly described and characteristic views are shown by means of lantern slides.

Coal Formation: J. J. STEVENSON.

The doctrine that the fossil fuels from peat to anthracite are a continuous series has been subject of renewed discussion within recent years. The writer felt compelled to make serious investigation to free himself from doubts aroused by the statements of some authors. The study proved unexpectedly difficult, for the disputants have very little common ground and one can hardly determine what kind of evidence may be acceptable to all. Some collateral matters, of much importance, have been overlooked and little information exists respecting them. These are chiefly chemical and the studies require extensive equipment as well as expenditure of much time, neither of which is at the writer's disposal. But assurances have been received from the presidents of several great organizations that the investigations will be made and that the results will be in readiness for the final summary. The general study has advanced so far, in the writer's opinion, as to justify presentation of the first part of his monograph. The plan adopted is to discuss the fuels in order of age, beginning with peat and closing with the Paleozoic coals. The first part considers peat and the Tertiary coals; the second will consider the Mesozoic and the Paleozoic coals. The writer hopes to make evident the inherent probability of the doctrine that, in spite of difference in plant materials, the coals throughout form a connected series, not merely in mode of accumulation, but also in physical structure and in chemical composition.

California Lakes and the Solar Hypothesis of Climatic Changes: ELLSWORTH HUNTINGTON.

Color Photographs of the Phosphorescence of Certain Sulphides: EDWARD I. NICHOLS.

By the use of a new form of phosphorescope the author has succeeded in taking photographs by the Lumière process, which shows the colors of certain phosphorescent sulphides of the Lenard and Klatt series. The change of tint by decay and the striking changes of color produced by cooling to the temperature of liquid air are exhibited by means of these photographs and the theory is very briefly discussed.

FRIDAY, APRIL 14

Afternoon Session—2 o'clock

William B. Scott, Sc.D., LL.D., Vice-president, in the Chair

A New and very Sensitive Indicator for Acidimetry and Alkalimetry and for Determining Hydrogen Ion Concentrations between the Limits of 6 and 8 on the Sorensen Scale: G. SCATCHARD and MARSTON T. BOGERT.

The authors have discovered that dinitro benzoylene urea (dinitro 2-, 4-diketotetrahydroquinazoline \rightleftharpoons dinitro 2-, 4-dihydroxyquinazoline) is an unusually sensitive indicator and one which can be prepared easily, in any desired amount, from anthranilic acid. It changes from colorless to greenish yellow with a change in hydrogen ion concentration from 10^{-6} to 10^{-8} , the development of the coloring following regularly the decreasing concentration of hydrogen ion. It is very little affected by neutral salts or proteins, and not at all by the ordinary biological preservatives, chloroform and toluene. The color does not fade perceptibly in two days, and but very slightly in a week. It therefore promises to be very useful in the measurement of hydrogen ion concentration of biological or other liquids in this important range, for which the previously known indicators are not very satisfactory. It is possible with it to detect the effect of one drop of N/100 NaOH in 100 c.c. of solution, and titrations of N/100 HCL with N/100 NaOH checked within 0.1 per cent. Under similar conditions -nitrophenol required 5 to 6 drops, and methyl orange 10 to 12 drops, to give a sure end-point. Its chief objection is its yellow color, which renders it unsuitable for determinations in artificial light.

Bacterio-chemical Studies of Decay of the Teeth: WILLIAM J. GIES.

The Human Gastric Secretion: MARTIN E. REHFUSS. (Introduced by Dr. Philip B. Hawk.)

Cerebral Localization: HARVEY CUSHING. (Introduced by Dr. Keen.)

The Inorganic Constituents of Marine Invertebrates: FRANK WIGGLESWORTH CLARKE.

It is a commonplace of geology that many limestones are formed from the remains of marine animals, such as corals, mollusks, crinoids, etc. Some of these limestones are magnesian, some are phosphatic and others are of the ordinary type, consisting chiefly of calcium carbonate. They were originally deposited at the bottom of the sea, and their composition depends upon the composition of the organisms which formed them. The present investigation has for its purpose to determine what each group of organisms contributes to the sediments; and in order to answer this question nearly 250 analyses have been made of the shells or skeletons of marine invertebrates, covering a range from the foraminifera up to the crustacea, and including also the corallin algæ. It was already well known that corals and molluscan shells were composed almost entirely of calcium carbonate, and that fact has been verified. The shells of one group of brachiopods, however, consist largely of calcium phosphate, and that substance is also abundant in the crustacea. These animals, and also vertebrate skeletons, contribute phosphates to the sediments. The foraminifera, alcyonaria, sea fans, echinoderms and calcareous algæ, with some minor groups or organisms, contain much magnesia, and therefore aid in the formation of magnesian limestones. Curiously enough, the amount of magnesium carbonate in any series of organisms varies with the temperature of the water in which the creatures lived; being small in cold and large in warm waters. A sea urchin from Greenland, for example, contained 6 per cent. of magnesium carbonate, and one from near the equator contained over 13 per cent. In certain algæ from the West Indies 25 per cent. was found. Furthermore, some organisms have their calcium carbonate in the form of aragonite, and others consist of calcite. The aragonitic organisms are all non-magnesian; while the magnesian forms are all calcitic. The data obtained in this investigation have been applied to the study of coral reefs, which owe their composition to all the creatures living upon them, and not to the corals alone. In fact, the corals are often of less importance than their associates.

Some Properties of Vibrating Telephone Diaphragms: A. E. KENNELLY and H. O. TAYLOR.

(A) *Dimensional Gases and the Law of Reflection of Gas Molecules from Solid Walls.* (B) *The Metallic Reflection of Light from a Gas:* ROBERT WILLIAMS WOOD.

Some Relations between Matter and Radiation: WILLIAM DUANE. (Introduced by Professor A. W. Goodspeed.)

To Benjamin Franklin we owe the fundamental conception that the phenomena of nature are due largely to the interaction of atoms of electricity with atoms of ordinary matter, and the object of this paper is to discuss the emission of radiant energy (light, heat-rays, X-rays, etc.) from the point of view of Franklin's conception. Since the discovery, some years ago, of cathode rays, X-rays and radioactivity scientists have had in their hands the means of producing and studying streams of atoms of both electricity and ordinary matter. They have succeeded even in observing effects due to a single atom of each kind. We now know that the impacts of atoms of electricity against atoms of ordinary matter produce radiation. Mr. Hunt, Dr. Webster and the author have been investigating the relations between the energy of the atom of electricity and the frequency of the radiation it produces. The most striking facts we discovered are that in the case of the so-called *general radiation* the energy required is strictly proportional to that frequency, and in the case of the so-called *characteristic radiation* the energy required is larger than in the preceding case and not always proportional to the frequency. The author offered the following explanations of these facts. High frequency vibrations are associated with the central parts of an atom of matter, in which the electromagnetic field is very strong. In order to reach a point in an atom of matter where a given frequency of vibration is produced the atom of electricity must have at least enough energy to overcome a certain force of repulsion acting between them. If we follow out the line of reasoning and apply Maxwell's distribution law and what has been called the fourth power law to the case of the atoms of electricity flying about in a hot body owing to its thermal agitation, we arrive at an equation for the distribution of energy in the spectrum that represents the facts with considerable precision. The above mentioned laws discovered by experimental investigation have a practical bearing on X-ray phenomena also. They indicate what must be done in order to produce those very high frequency radiations that hitherto have been obtained from radioactive substances only.

Relation between Changes in Solar Activity and the Earth's Magnetic Activity, 1902-1914:

LOUIS A. BAUER.

No criterion of solar activity, whether it be the spottedness of the sun, or the faculae, prominences, or calcium flocculi, has been found to synchronize precisely with any quantity used as an index of the earth's magnetic activity. Thus, for example, the maximum magnetic activity in 1892 preceded the maximum sunspot activity of that period by a year. So again the recent minimum magnetic activity of the earth seems to have occurred in 1912, whereas the minimum sunspot activity did not take place until 1913, or a year later. Then again the amount of magnetic activity is not necessarily commensurate with that of solar activity, whatever measure of the latter be used. When the comparisons between the solar data and the magnetic data are made for intervals of less than a year, a month for example, as was done in my paper before this society in 1909, the lack of exact synchronism and the lack of proportionality between the two sets of changes become especially noticeable. Fortunately, beginning with 1905, we have a new set of figures, the values of the solar constant, determined with high precision at Mount Wilson, California, by Dr. Abbot. Remarkable fluctuations are shown in these values, amounting at times to 10 per cent. of the value. The present paper makes a comparison between the annual changes in the values of the solar constant for the period 1905 to 1914 with the irregularities in the annual changes of the earth's magnetic constant. It is found that the two sets of data, in general, show similar fluctuations. Also, a closer correspondence is found between those two sets of changes than between either set and that of sunspot frequencies. In brief, the solar-constant values furnish another index of changes in solar activity which may be usefully studied in connection with minor fluctuations in the earth's magnetism. In conclusion, it was pointed out why none of the mentioned criteria of solar activity can be used as an adequate measure of the various ionizing agencies ultimately responsible, according to present belief, for the magnetic changes recorded on the earth.

FRIDAY EVENING, APRIL 14

Reception from 8 to 11 o'clock at the hall of the Historical Society of Pennsylvania, S.W. corner of Locust and Thirteenth Streets, at 8:15 o'clock. Leland O. Howard gave an illustrated lecture "On Some Disease-bearing Insects."

SATURDAY, APRIL 15

Executive Session—9:30 o'clock

Stated Business.—Candidates for membership balloted for. As a result of the election the following were elected as members of the society:

Residents in the United States

William Wallace Atterbury, A.M., Radnor, Pa.; Maxime Bôcher, A.B., Ph.D., Cambridge, Mass.; Percy William Bridgman, Ph.D., Cambridge, Mass.; James Mason Crafts, S.B., LL.D., Boston, Mass.; Henry Platt Cushing, Cleveland, Ohio; Edward Murray East, M.S., Ph.D., Boston, Mass.; Frank Rattray Lillie, Ph.D., Chicago, Ill.; William E. Lingelbach, A.B., Ph.D., Philadelphia; Daniel Trembly MacDougall, A.M., Ph.D., Tucson, Ariz.; Charles Frederick Marvin, M.E., Washington, D. C.; Lafayette Benedict Mendel, A.B., Ph.D., Sc.D., New Haven, Conn.; Forest Ray Moulton, Ph.D., Chicago, Ill.; Eli Kirk Price, A.B., LL.B., Philadelphia; Erwin Frink Smith, Sc.D., Washington, D. C.; William Morton Wheeler, Ph.D., Boston, Mass.

Foreign Residents

Frank Dawson Adams, D.Sc., Ph.D., F.R.S., Montreal; Wilhelm L. Johannsen, M.D., Ph.D., Copenhagen; Joannes Diderik van der Waals, Ph.D., Amsterdam.

Morning Session—10 o'clock

Edward C. Pickering, D.Sc., LL.D., F.R.S., Vice-president, in the Chair

Age Cycles and Other Periodicities in Organisms:

C. M. CHILD. (Introduced by Professor C. E. McClung.)

Experiments with various forms among the lower invertebrates show that senescence occurs in those forms as in the higher animals, but that rejuvenescence also occurs in asexual reproduction, in the reconstitution of pieces experimentally isolated and also during starvation. These organisms may pass through alternating periods of senescence and rejuvenescence without death and often without reproduction. The experimental evidence indicates that senescence consists physiologically in a decrease in the general metabolic rate, conditioned by the modifications of the colloid substratum and the progressive accumulation of relatively stable structural substances during growth and differentiation. Rejuvenescence is physiologically an increase in general metabolic rate conditioned by the chemical breakdown and removal of such modifications under certain physiological conditions. The sex cells are physiologically old, highly differentiated cells and the early stages of embryonic de-

velopment constitute a period of rejuvenescence. Many other periodicities in organisms are of the same general nature as the age cycle. Fatigue, recovery, the loading and discharge of gland cells, various seasonal periodicities, alternating active and quiescent periods, etc., depend to a greater or less degree on modifications of the protoplasm by metabolism and the following removal of such modifications under altered metabolic conditions.

Cooperation as a Factor in Evolution: WILLIAM PATTEN. (Introduced by Professor H. H. Donaldson.)

The purpose of this discussion is to show that cooperation, or the summation of power, is the creative and preservative agent in evolution, and that the summation of power depends on cooperation in the conveyance of power. The *vis a tergo* in life is the product of internal cooperative exchange (metabolism). Growth is profitable exchange, or the increase of the power of exchange due to the local accumulation of those agents whose demands are the impetus to exchange. The rate at which growth proceeds depends on the capacity of its conveyers, that is on their capacity to convey things to and from the growing points, or the growing points to the sources of supplies. Growth creates a power which is used as a means to satisfy its own demands, and a surplus power for "freedom" of action, which is used to experiment and explore, or to find better ways and means of satisfying its demands. Growth, therefore, follows the easiest, most accessible, and most profitable lines of conveyance, and its products accumulate along the lines of least resistance. Growth inevitably creates diversified conditions which tend to check its own progress till relieved by better cooperation. For growth reduces the immediately available supplies, thereby requiring greater expenditures to procure them; and the new internal conditions created by growth create new products, with new demands, faster than the right ways of ministering to them can be found. The larger demands, under reduced resources, can only be supplied by better cooperation in the common service of conveyance; but as fast as these demands are satisfied, producing new growths, further demands are created, to satisfy which requires still better methods of cooperation. The same laws which prevail in the inner and outer life of animals and plants prevail in the social life of man. Man's social progress is measured by the degree to which he has extended the mutually profitable give and take of cooperative action beyond him-

self, to the family, tribe, state and into the world of life at large. The chief agents of civilization, language, commerce, science, literature, art and religion are the larger and more enduring instruments of conveyance, which better enable the part and the whole to avoid that which is 'evil' and to find that which is "good," and which yields a larger surplus for "freedom."

On the Effects of Continued Administration of Certain Poisons to the Domestic Fowl, with Special Reference to the Progeny: RAYMOND PEARL.

Types of Neuromuscular Mechanism in Sea-Anemones: GEORGE H. PARKER.

In the origin of nerve and muscle the sea-anemone has been supposed to represent a step in which a nervous set of very primitive structure could throw into prolonged contraction the general musculature of the animal's body. An examination of the body of the sea-anemone shows that its muscular activities are of a much more diverse kind. They include, first, muscles that act under direct stimulation and without the intervention of nerves; secondly, muscles that are stimulated directly as well as by nerves; thirdly, muscles that are stimulated only by nerves and exhibit under these circumstances profound tonic contractions; and, finally, muscles that react in the same reflex way that those in the higher animals do. This diversity of muscular response has not been fully appreciated by previous workers.

Determination of Stellar Magnitudes by Photography: EDWARD C. PICKERING.

An immense amount of work is being carried on by observatories all over the world, in determining the photographic magnitudes of the stars. It is of the utmost importance that all of these magnitudes should be reduced to the same scale. Accordingly, in April, 1909, an International Committee was appointed with members from England, France, Germany, Holland, Russia and the United States. This committee met in 1910 and 1913, and, after a most amicable discussion, agreed on a system, in which all stars were to be referred to a Standard Sequence of stars near the North Pole. The magnitudes of the latter were determined at Harvard by Miss H. S. Leavitt, by six different methods, using eleven different telescopes, having apertures from one half to sixty inches. All gave accordant results, and were adopted by the committee. A simple method was found for transferring these magnitudes to stars in other parts of the sky, but here extraordinary sources of systematic errors presented themselves. For in-

stance, if two equal exposures were made on a plate, the second was found to give fainter images; if, by means of a small prism, exposures were made simultaneously with different apertures, the smaller aperture indicated a brighter magnitude than the larger, when the stars were bright, and a fainter magnitude when they were faint. The color equation was found to vary by different amounts not only for different instruments, but for different magnitudes.

Monochromatic Photography of Jupiter, Saturn and the Moon. (Illustrated by Color-photographs made with the Mt. Wilson 60-inch telescope): ROBERT WILLIAMS WOOD.

On the Eclipses of Jupiter's Satellites: JOHN Q. STEWART. (Introduced by Professor H. N. Russell.)

On the Probable Temperature of Mars: HENRY NORRIS RUSSELL.

A New Catalogue of Variable Stars: ANNIE J. CANNON. (Introduced by Professor E. C. Pickering.)

The first variable star was discovered in 1596, and two hundred years later, when the first Catalogue was made, there were but twelve known. A catalogue of 113 variable stars was published in Germany in 1865. In 1888 when the first catalogue of them was made in America, the list contained 225 stars. About this time, the Harvard photographic work was established by the director, E. C. Pickering. One of the first results of a study of these photographs was the discovery of large numbers of variable stars. They were found by four methods: by arranging groups of stars in sequences; by the presence of bright lines in their spectra, when photographed with an objective prism; by multiple exposures on the same stars throughout the whole night; and by superposing a glass positive and negative of the same region. The globular clusters, the Magellanic clouds, and the map of the sky have proved fruitful fields for this investigation. So great has been the increase in number that a new Catalogue now being compiled contains 4,641 stars, of which 3,397, or nearly three quarters of the whole, have been found at Harvard, and 1,244 elsewhere, by astronomers in nearly all portions of the civilized world. The variable stars are divided into five classes, dependent upon the character of their variation in light. The periods vary from two hours to 698 days. Determination of the periods and light curves of these stars constitute a large piece of work. Much has been done at Harvard

in this field, and many observations have been furnished other astronomers for such determinations. No more suitable place could be found for the preparation of this catalogue than the Harvard Observatory, for the rich library of a quarter of a million stellar photographs furnishes the only complete material in the world for the study of these stars during the last twenty-five years. By examining the past history of a star on these photographs, the investigator may far more readily find an answer to such perplexing questions as to whether a star is variable or constant, what is the length of the period, is the period changeable, what is the color or the spectrum of the star, than by waiting months or years to accumulate additional observations.

Legal and Political International Questions and the Recurrence of War: THOMAS WILLING BALCH.

SATURDAY, APRIL 15

Afternoon Session—2 o'clock

William W. Keen, M.D., LL.D., President, in the Chair

Symposium on International Law: Its Foundation, Obligation and Future:

Outline: HON. JOHN BASSETT MOORE.

Judicial Aspects: International Arbitration: HON. CHARLEMAGNE TOWER.

Legislative Aspects: GEORGE GRAFTON WILSON. (Introduced by Hon. John Bassett Moore.)

Administrative Aspects: PHILIP MARSHALL BROWN. (Introduced by Hon. Charlemagne Tower.)

World Organization: HON. DAVID JAYNE HILL.

On Saturday evening, April 15, at 7:30 o'clock, the annual dinner was held in the North Garden of the Bellevue-Stratford, at which more than one hundred members and guests were present. The president was particularly happy and witty in his introductions of the speakers, who responded to the toasts as follows:

"The Memory of Franklin," by Professor A. Trowbridge.

"Our Sister Societies," by Professor R. A. Millikan.

"Our Universities," by Professor J. M. Coulter.

"The American Philosophical Society," by Professor F. E. Schelling.

Thus ended perhaps the most notable meeting since the Franklin Celebration.

ARTHUR W. GOODSPEED

PHILADELPHIA,

April 17, 1916